Influencing factors on the occurrence of road accidents with a special emphasis on motorcyclists in national and global research; a review of the studies conducted in Iran and the world

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Abstract

Objective: Road traffic injuries are one of the major causes of death among youth who are drivers of vehicles, such as motorcycles, all over the world. Road traffic injuries are a major public health problem in Iran. Half of road traffic injuries occur among motorcyclists and the risk of occurrence of death or severe injuries among motorcyclists is 10 times more than other vehicle users. Hence, identifying factors affecting the occurrence of accidents is vital. This study aims to explore these factors as the focus of national and international research.

Method: Data were extracted from English and Persian language published articles in Iran and the world. Articles were selected from PubMed, Scopus, Elsevier, ProQuest, databases of medical sciences and also reports related to accidents by using relevant keywords. Finally, 68 articles entered the review. Data were analyzed based on objectives of the study.

Results: The focus of most studies was on individual factors, while environmental factors have received least attention. Data analysis showed that four major groups of issues related to motorcycle traffic injuries were assessed. Factors related to vehicle was explored in 22.05% of studies, environmental factors in 17.64% of studies, human factors in all studies, and factors related to laws in 58.82% of studies.

Conclusion: Although human factors including risky behaviors play an important role in the occurrence of accidents, they have roots in environmental, managerial, legal and vehicle factors. Therefore, there is a great need to explore these factors in future research and programs aiming to reduce road accidents

Key words: Motorcyclist, High risk behaviors, Injuries, Systematic review

Context

Road accident is one of the main causes of mortality due to injuries which leads to 1.2 million deaths annually and 90% of these deaths are related to the developing countries (1). It is estimated that for each of these deaths at least 20 people, totally 20-50 million, will suffer annually from non-fatal injuries (2). Of course, since non-fatal injuries are less registered, this statistic is less than the actual amount. The total amount of road traffic fatalities is 18 per 100,000 population (3). The roads will be considerably more dangerous and the probability of injuries and death for the users will be increased with the rapid increasing number of cars and two-wheel vehicles in developing countries (5).

Evidence Acquisition

Traffic accidents other than death, injuries and disabilities lead to other social, psychological, and economic consequences at the individual, family and national levels (2, 9). Injuries caused by traffic accidents lead to a great demand for health care services in the form of financial resources, occupation of hospital beds and the need for health professionals (10). Also, this problem can put pressure on the health system of the country already struggling with the limitations of their resources (3). The cost of injuries caused by road accidents is estimated at approximately 1% of Gross National Product (GNP) in low-income countries, 1.5% in middle-income countries, and 2% in high-income countries (2). Thus, traffic accidents have a significant impact on the economy of the countries, especially low or middle income countries which are often faced with other growing needs as well (3, 11).

Iran had the highest transport-related deaths in the world in 2008 and about $ 6 billion is spent due to traffic accidents annually in the United States [8]. By approving and implementing the new law on dealing with driving offences in 2010 and 2011, the trend of fatal traffic accidents has been decreased to about 20 thousand deaths in 2012 and 17 thousand deaths in 2015. Although this reduction is pleasing, these deaths are still very high either relative to the population, or relative to the number of vehicles especially compared to the high-income countries.

Although traffic accidents have been effective in all age groups (7), road traffic injuries are the major cause of mortality worldwide among young people who are the drivers of cars or two-wheel vehicles, so that almost 60% of road traffic deaths occur in the age group of 15-44 years old (4). According to the report of the World Health Organization (WHO) in 2015, the contribution of death in road accidents has been 31% for the vehicle occupants and the remaining 19% have been divided between the uncertain users of the road (1). 49 percent of the total road traffic deaths occurred among pedestrians (22%), cyclists and tricycles (5%) and motorcyclists (23%), showing that half of these deaths or in other words a quarter of all road deaths occur among motorcyclists (1,4). Of course, this pattern is not necessarily observed in all countries. The 2015 report of WHO also indicates that the ratio of deaths of motorcyclists has largely remained unchanged since 2010 (4). Pedestrians and motorcyclists suffer the most severe injuries in vehicle accidents compared to the other road users; their medical problems are more ongoing and they need more help (7, 8).

Today, the motorcycle has become a means of urban transportation and is responsible for a significant contribution of traffic movements (12). Considering the heavy traffic and slow transportation caused by the mass production of cars, motorcycle can easily pass through crowded streets or narrow passageways due to their high speed, low volume and high mobility power, and that is why, driving it is very popular among people, especially youth (12).Also they are cheaper than cars and this must be a contributing factor.

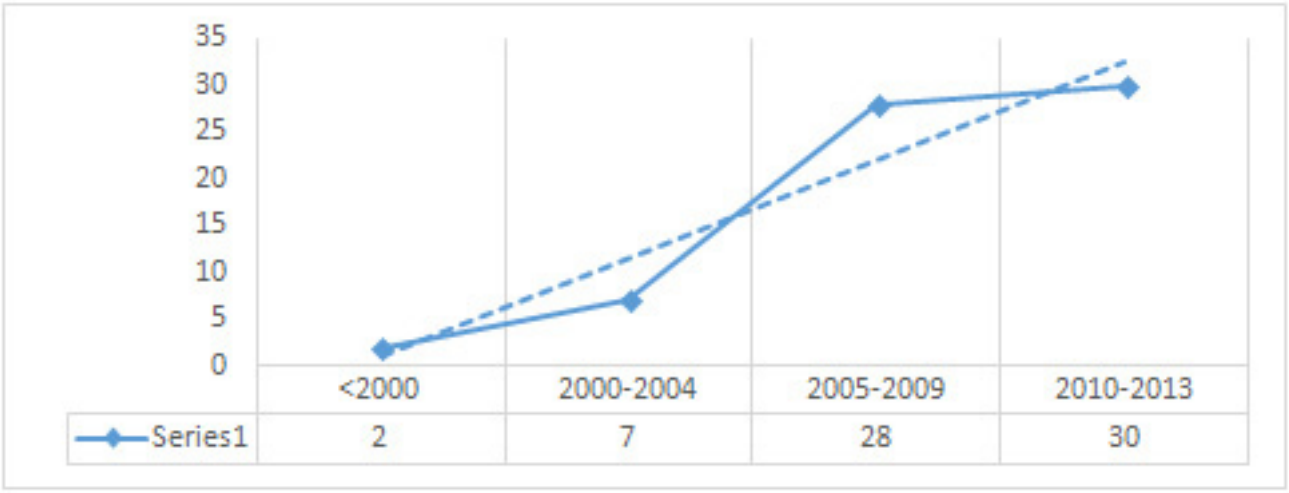
The number of and amount of use of motorcycles and bicycles for the goals of transportation and entertainment are increasing at the global level. Motorcyclists form a large part of the registered vehicles in Iran, for instance, they formed about 40% of vehicles in 2005 [8]. Motorcycle is considered the most vulnerable type of motor vehicle for several reasons. These reasons are: the shortage of protective cover, the low age of their drivers, minimum need for training, the limited conditions of driving tests and easy vehicle inspection. All of these factors may increase the rate of injuries caused by road accidents in the region (2). The studies show that the occupants of two-wheel motor vehicles are 20 times of cyclists, 8 times of pedestrians, and 9 times of vehicle occupants at risk of death (7). So it is necessary to identify the influencing factors on motorcyclists' road accidents and the severity of injuries to develop effective preventive measures (4).

In this review, only the studies published in two languages, English and Persian, were investigated. First, a wide and advanced search on all databases such as: EBSCO،‹ Science direct ،‹ Medline‹ INLM‹PMDR،‹ Wiley‹ ،Cochrane‹ PubMed‹ ProQuest‹ Scopus‹ Consult‹ Biomed central‹ Elsevier‹ Springer, and search for the articles from internal scientific-research sites Random‹ SID‹ Magiran‹ IRANMEDEX‹ MEDLIB were conducted using the relevant keywords such as»Motorcyclist», «Risk behavior», and «injury » in the studies of 1998 onwards. As a result of this search, 147 articles were identified and extracted. The articles which were not original research, or related, didn't have full text or valuable information and clear and adequate explanation and specific results, were excluded from the selection cycle. Finally 68 articles (14-43) on traffic accidents related to the motorcyclists' traffic accidents were separated to enter the study after excluding the repetitive articles and using the exclusion criteria. Information was extracted and entered into the pre-prepared tables. The data were then classified and analyzed quantitatively and qualitatively.

Results

Different studies have been conducted in various methods and different goals on traffic accidents of riding motorcycle which have attempted to identify the factors effective in the occurrence of accidents.

Chart 1: Timeline for conducting the studies from 1998 to 2013



Studies were categorized in 4 groups of review studies (14 studies), descriptive-analytical studies (41 Studies), qualitative and combined research (8 studies) and interventional studies (5 Studies). Summary information of these studies has been summarized in Tables 1, 2, 3 and 4.

Table 1: Classification of the reviewed studies based on the type of study

Row	Characteristic of studies	Iran studies	World studies	The total studies
1	The number of reviewed studies	3	11	14
2	The number of analytical descriptive studies	15	26	41
3	The number of qualitative and combined studies	7	1	8
4	The number of interventional studies	2	3	5
5	The total studies	27	41	68

Table 2: Summary of the review studies

Row	Author, year, country	Title	Study population/ sample size	Data collection method	Results	Investigated factors affecting the accident
1	Herman et al., 2012, Auckland and New Zealand	Burden of road traffic injuries and the risk factors associated with it: a review of studies conducted during 1980-2010	Related studies - 1279 people	Documentary review: Related studies published	Road injuries were the most common cause of death) or hospitalization which was more observed among men. Head injuries was the most common cause of death or hospitalization. Two thirds of deaths had been occurred at the place of the accident or after entering the hospital. Most victims were passengers or pedestrians.	Gender, age, travel time, travel with unprotected equipment, crowd, traffic of vehicles and alcohol
2	Albalate et al., 2010, Barcelona	The severity of injuries caused by motorcycle: The role of the type of vehicle and the crowd	Barcelona 175,037 cases of the road violations	Documentary review: Data collected by the police in 2002-2008	Crowd and density of the roads reduce the severity and suffering of severe injuries, The severity and injuries caused by the motorcycles 2.3 times more than other vehicles	Gender, speed, road width, alcohol consumption, crowd and density of the roads, climate conditions

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3	Rodrigues et al., 2013, Geneva	The process of motorcycle fatal injuries in the United States in 1998-2010	17 countries of Pan American region	Documentary review: Pan American Health Organization Database (PAHO / WHO, 1998-2010)	The overall rate of death caused by the motorcycle had been from 0.8 to 1.6 per 100,000 people. The highest death rates were in Colombia with 3.6 and the lowest rate was in Chile and Ecuador with 0.2 per 100,000 people. Most deaths were observed in the age groups of 15- 24 and 25-34 years old	Gender, age group, socio-economic characteristics of the region, income level
4	Kardamanidis et al., 2010, Australia	Training for the motorcyclists to prevent the road traffic injuries (review)	Database data	Documentary review: Cochran data of 2008 and other database data without time limitation	Most of the studies had weakness of a serious method, lack of control confounding factors, mere relying on the police' information, small size of samples and short time of follow up. Duration of training was from 3 hours to 3 days and most of the training was theoretical or practical and without evaluation.	Duration of training, type of training, the use of helmet, Traffic rules, driving experience, the amount of breaking the law, accidents, injuries and deaths
5	Roung Lin et al., 2009, America	Investigating the risk factors and patterns of motorcycle injuries	220 titles of articles	Documentary review: From Medline data	Deaths caused by the motorcycle were 34 times greater than other vehicles. Head injury leads to more death than other motor vehicles. The helmet is effective in reducing this injury. Alcohol is the major cause of fatal accidents.	Injury pattern, helmet and other safety equipment, alcohol, modifiable factors, the severity of the injuries, age group, gender, socio-economic status, Haddon Matrix, drugs, driving instruction and motorcycle riding skills, driving license, speed, risky behaviors
6	Liu et al., 2009, England	Articles	Documentary review: Databases of Cochrane, MEDLINE, EMBASE, CINAHL, TRANSP, TRIS, ITRD, IRRD, ATRI	Documentary review: Studies of databases and consultations with the researchers.	The most effective preventive measure is in the behaviors related to the accidents, structural and environmental reforms, and the interventions have the greatest impact on learning of the community members when to be done as face-to-face communication in small groups.	Type of accident, the target group, location, vehicle safety equipment, training messages, rewards for desirable behaviors, rules and regulation, environmental reforms and the products, prevention measures and their integration, geographical region, culture

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7	Lund et al., 2004, Norway	Preventing accidents. Providing a model with an emphasis on the individual, structural and cultural factors	Studies of databases	Documentary review: Studies of databases and consultations with the researchers.	The most effective preventive measure is in the behaviors related to the accidents, structural and environmental reforms, and the interventions have the greatest impact on learning of the community members when to be done as face-to-face communication in small groups.	Type of accident, the target group, location, vehicle safety equipment, training messages, rewards for desirable behaviors, rules and regulation, environmental reforms and the products, prevention measures and their integration, geographical region, culture
8	Ghorbani Birgani et al., 2012, Khuzestan	Epidemiological study of fatal traffic accidents in Khuzestan Province in 2010	7856 records of 24 cities of Khuzestan province	Existing documents all dead individuals who have been died due to the traffic accidents and have been referred to the Legal Medicine Centers.	45% of the head injuries victims and 35% of the dead individuals had been in the age range of 15-30, and the cause of death of 57% of fatal accidents was due to the passenger cars and in the suburban roads. The highest percentage of victims was the occupants of passenger cars with 46.5% and motorcyclists with 21.5%.	Age group, gender, place of residence, time of death, place of death, driver, occupant or pedestrian, type of vehicle, the injured anatomical area and the main causes of death.
9	Hashemi Nazari et al., 2011, Khuzestan	Investigating the 5-years process of deaths caused by traffic accidents in Khuzestan province (2006-2010).	Accidents-related records of Legal Medicine Centers	Documentary review: Statistics of fatal traffic accidents referred to the Legal Medicine Center of the Province in the 5-years period.	On average, 7% of deaths caused by accidents have been decreased in 2006-2010. Most of the dead individuals are drivers with 45.06%, occupants with 32.83% and pedestrians with 21.53%.	Strikes, gender, education, mortality, dead individual' status, location of accident, location of death.
10	Zokaei Alamdari et al., 2011, Urmia	An exploration of the relationship between the economic development and death caused by the road accidents in Iran	30 provinces of the country during 2005-2008	Documentary review: Legal Medicine Center, Iran Statistics Center, institute of Iran Statistics Center and statistical yearbooks of Iran transportation and terminals organization	There is an inverse U-shape relationship between the economic growth and casualties caused by the road traffic accidents. Unequal distribution of income has a positive impact on the casualties. Therefore, higher levels of the per capita income along with adopting the policies effective in reducing the accidents and eliminating the accident-prone point scan improve the situation.	Accident-prone points, economic growth, casualties caused by the road accidents, income, roads length.

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11	Hartling et al., 2004, Canada	Issuing the driving license to reduce the accidents of young drivers	16 years old individuals who were teenage driver	Documentary review: Databases, government websites as well as consulting with the experts and authors	Reduction was observed for all types of accidents among all teenage drivers. Reduction in the various programs during the first year was 31%. Rate of accidents during the prohibited hours of commuting (5 am -22) had a 17 percent reduction for the drivers with license limitation. There was also a 19 percent reduction for the prohibition of alcohol consumption.	Fatal injuries, alcohol, driving limitation at night, being admitted to the hospital, issuing the driving license, being teenage the passenger, condemnation experience, damage to property.
12	Macpherson et al., 2006, Australia	The law of the use of helmet to attract the use and prevent further injuries	Studies	Documentary review: Search in the electronic databases such as: CENTRAL, Cochrane, MEDLINE, EMBASE, TRANSPORT and government websites	In the studies on the use of helmet, some changes in the amount of head injuries and the use of helmet were observed. Significant changes were observed in reducing the head injuries in implementing the law.	The use of helmet, injuries
13	Kardamanidis et al., 2008, Australia	Training for the motorcyclists to prevent the road traffic injuries	Studies	Documentary review: From all data of Cochrane, TRANSPOR, MEDLINE, EMBASE, CINAHL,WHO, LILACS , SSCI, ERIC, ZETOC, SIGLE	Most studies had a weakness in methodology and had no method to control confounding factors and were non-random and had been used inappropriate measuring tools. The sample size was small and the time of follow up was short. Therefore, it was not able to conclude on the effectiveness of training.	Formal and informal training at different levels, driving license, training time, gender, age, experience of riding motorcycle, previous driving experiences (crime, injury), previous training, speed, alcohol / drug consumption
14	Hurst, 2011, England	An investigation of texts and exploratory analysis of deaths accidents leading to the serious injury in the motorcyclists	Studies	Documentary review: The library investigation of the studies	51% of the serious injuries and 48% of mortality were in the afternoon (12-18 pm), 55% of injuries and 72% of casualties have been occurred on rural roads,60% of injuries and 39% of deaths at intersections, 20% of injuries and 29% of deaths in road twist, 25% of injuries and 25% of deaths due to the speed, 12% of injuries and 12% of deaths due to theovertaking,15% of injuries and 30% of casualties due to the collision with an obstacle.	Day hours, weekend holidays, the summer, speed, good weather, dry road, motorcycle size, obstacles, intersections and road twist, motorcycle capacity, demographic characteristics, individual differences (risk taking, seeking excitement, attitude, motivation, social factors), educational, breeding, legal, and engineering initiatives

Table 3: Summary of descriptive analytic studies

Row	Author, year, country	Title	Study population/ sample size	Data collection method	Study result	Investigated factors affecting the accident
15	Teschke et al., 2012, Canada	Personality and travel features related to the use of healthy equipment by the adult injured cyclists: A cross sectional study	The adult injured cyclists (more than 19 years old) who had been hospitalized less than 24 hours in the emergency room.	Interviews with the eligible participants in relation to investigating the amount of use of the bicycle lights, the specifying clothes and helmet.	The use of bicycle lights in all trips was 20%, but on the night trips was 77%. The amount of use of colored specifying clothes was 33% and the use of helmets on trips was a total of 69%. It was 76% in Vancouver where there was the law of using the helmet, and was 59% in Toronto without law.	Travel at night, inappropriate climate conditions, weekly travels, the use of helmet, travel on long distances, the type of bicycle, the lack of use alcohol within 6 hours before travel, age, and higher income, the purpose of travel and higher education.
16	Lang ley et al., 2012, New Zealand	The effects of age, time and being teammate in the incidence of the motorcyclists' casualties in traffic accidents.	The motorcyclist and the carrier who had been injured in riding the motorcycle during 1979-2008.	Data was obtained from database of the Ministry of Health and hospitals and the injured motorcyclist and the carrier (aged 10-69) or those who had died less than 30 days after the accident or had been treated less than one day in 12 age groups.	Data was obtained from database of the Ministry of Health and hospitals and the injured motorcyclist and the carrier (aged 10-69) or those who had died less than 30 days after the accident or had been treated less than one day in 12 age groups.	Age, time, casualties, injuries
17	Ackaah et al., 2013, Mexico	The use of non-standard helmet in low-income and middle-income countries: A multi-focal study	5563 motorcyclists with helmets and the passengers and marketers and investigating the law	A survey of marketers and investigation of the law and the method of implementing it regarding non-standard helmets in nine countries China, Ghana, India, Malaysia, Mexico, Nigeria, Pakistan, Thailand and Vietnam.	The lack of the use of helmet (due to the price), while 7 of 9 countries studied had the law of prohibition of the use of non-standard helmet. Only 4 of them had the law of production and sale and only 3 of them had the law of prohibition of imports. Implementing the law was also too weak.	The lack of the use of helmet (due to the price), while 7 of 9 countries studied had the law of prohibition of the use of non-standard helmet. Only 4 of them had the law of production and sale and only 3 of them had the law of prohibition of imports. Implementing the law was also too weak.

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18	Daly et al., 2013, Australia	Studying the population based on case-control on non-fatal motorcycle accidents	Studying the population based on case-control on non-fatal motorcycle accidents	The questionnaire was completed by the motorcyclists, the observed information of the road was also collected from a location (about a kilometer), and the speed of the vehicle was estimated through these data.	The risk factors are the speed and infrastructure of the roads and have a role in the accidents, age, experience and training.	Demographic factors, medical status, the reasons for riding motorcycle, experience, training, the behaviors of riding motorcycle, speed of accidents, alcohol and drugs, type of motorcycle, security features,; engine, capacity, date of fixing and maintenance, travel factors (weather and light conditions, length and purpose). Traffic density; the presence of other riders; driving license, individual protective equipment and sight (use lights, color of clothes), road infrastructures (type of road, width, shoulder, type of intersection; curvature topography, marking line, traffic, control devices)
19	Crankson, 2006, Saudi Arabia	Damages (injuries) of motor vehicles in children: a research based on hospital data	Children under 12 years old	Medical chart of the children injured by the motor vehicles and the reasons for it were investigated. According to the medical records from 1994 to 2003, the physician' reports and data were analyzed.	Medical chart of the children injured by the motor vehicles and the reasons for it were investigated. According to the medical records from 1994 to 2003, the physician' reports and data were analyzed.	Age, gender, mechanism of injury, type of injury, management and outcome
20	Mikocka et al. 2010, Australia	Age, gender, mechanism of injury, type of injury, management and outcome	Motorcycle-related injuries: Profile and the cases of incidence of injury in unauthorized ways and routes for motorcycles (along the street – sidewalks)	Information about the major injuries and damages registered in the national legal medicine information system, NCIS database, 10 years from 2001 to 2008 was prospectively collected. This information included the patients, survivors and the dead individuals.	1157 people had been injured by the accident. The incidence of injuries was higher in unauthorized routes. (76%) of the survivors and (87.5%) of the dead individuals by the accident had occurred on unauthorized routes. 344 people had died of the accident.	Road type, weekdays, mortality, injury, age, gender

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21	Stella et al., 2002, Australia	Most of fatal head injuries caused by motorcycle accident are due to the low driving skills.	Cases of deaths caused by the accident with motorcycle	Data of database of Western Australia Coronial government and investigation of deaths related to the head injuries as well as the preliminary report of the police were used and a 2-year retrospective study was conducted from 1998 to 1999.	Young men and insecure riding behavior are the major causes of brain damage related to the motorcycle deaths, because (56.4%) died at the age range of 29-15 years old and (64.1%) died in the accident scene. (30.8%) of cases had been consumed alcohol and (28.2%) drugs. (30.8%) of cases had high speeds and (12.8%) had not been used appropriate secure equipment.	Age, gender, location, type of accident, the role of speed, ethanol or other drugs, and the use of secure equipment
22	O KyungHam, 2007, South Korea	Psychological factors associated with life span experience after unwanted serious injuries	24327 people aged 19-65 years	Secondary data were collected from NHNS.13, 200 households were randomly classified and a face-to-face interview was conducted on health behaviors and psychological characteristics.	63.9% had a history of traffic accidents. There was a statistically significant relationship between high-risk behaviors (drinking wine, the lack of use of seat-belts and driving with alcohol), limitation of daily activity, suicidal thoughts, alcohol consumption and the experience of accident. There was appositive relationship between higher age, education, income, inappropriate occupation and accident.	Age, being male, low literacy, low income, occupation (being a worker), membership in medical targeting programs, marital status, type of insurance, place of residence, accident history, cause of accident, type of injury, quality of life, alcohol consumption in driving, fasten seat belt
23	Phillips on et al., 2012, Tanzania	Information and consequences of injuries of the victims of traffic accidents to Bugando Medical Center in Tanzania	Accident victims	Data from all patients referring during (2010-2011)by selecting all age and gender groups regardless of the severity of the damage caused by the road injuries were collected using a questionnaire. The severity of injury was calculated using the Kampala injury criterion.	The mean of hospitalization was 23.5 days.3.8% had a permanent disability. The mortality rate was 17.5%. Alcohol consumption before the accident had been reported in 17.2%. Motorcycle was responsible for 58.8% of road accidents.	Age, occupation, gender, mechanism of injury, severity of injury, systolic blood pressure over 90 and head injury, scores of trauma, injured area, treatment provided, complications due to the treatment, duration of hospitalization, mortality and disability, alcohol consumption, the waiting time
24	Imran Khan et al., 2008, Pakistan	The factors associated with the use of helmets in Pakistan's Karachi motorcyclists	The motorcyclists	Through interviewing and self-reporting and investigating 300 motorcyclists randomly in three parking sessions at busy times	(56%) had used helmets to prevent the injury and have had better training than other people. There was no significant difference between two groups between the mean of age, marital status and awareness of the laws of the use of helmets.	Age, marital status, frequency of the use of helmet, the reasons for the use or lack of use, awareness of the laws of the use of helmets, income, education
25	Lower et al., 2003, Australia	Accidents caused by the motorcycles of agriculture sectioning adolescents in Western Australia	Students of Australian Colleges of Agriculture	Data were collected using a questionnaire through a targeted sampling of 326 students in 2 times in 2 weeks intervals.	48% of all students had been injured. Approximately one-third of the injured individuals were needed to the medical treatment. The most predictors were the high speed and the lack of permanent use of helmets.	Speed, the use of helmet

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26	Eric et al., 2010, USA	The role of the type of motorcycle in fatal accidents of the motorcycle	The motorcyclists	The motorcyclists who had been used 12 types of motorcycles (according to the researchers' classification) were investigated. Data of the motorcycles was obtained from R.L. Polk company during 2000 and 2003 to 2008, and data of samples was obtained from the FARS reporting system.	The deaths were 27,524 people during 2000-2008. The deaths of SUPERSPORT motorcycles were 4 times higher than other types. The reasons had been related to the risky behaviors such as speed and alcohol consumption.	Age, gender, blood alcohol concentration (BAC), driving license status, the use of helmet, the conditions of accident such as speed; motorcycle identification number, motorcycle model
27	de Rome et al., 2011, Australia	The effectiveness of motorcycle protective clothes: the results of drivers' health in 6 months after the accident	The effectiveness of motorcycle protective clothes: the results of drivers' health in 6 months after the accident	Data was collected through face-to-face interviews at home or two weeks after the accident in the hospital and investigations of the medical records during 2008-2009 for 12 months were collected. Samples were selected from two hospitals and 13 repair shops of the motorcycle. Evaluation was conducted 2 and 6 months later by post.	The injured motorcyclists who had worn protective clothes had fewer hospitalization days and less pain after the accident and less probability of disability in physical activities and generally faster complete improvement than other motorcyclists, especially when the guard covered the entire body.	Accident, severity of injury, protective clothes, demographic characteristics, 4 components of physical health (physical function, physical role, physical pain, general health), type of motorcycle, duration of hospitalization
28	Zambon et al., 2006, Sweden	Zambon et al., 2006, Sweden	The motorcyclists	Data of police' reports and hospital-based reports during 1988 to 1995 on mild and severe injuries and deaths of the motorcyclists born in 1970-1972 were collected.	1567 people had been injured and 467 people died. There was a significant difference between the incidence of injury at the age of 17 and other ages. The most difference in the injuries was observed in the socio-economic groups at the age of 17-19 years. The incidence of injury at the age of 18 in the low socio-economic class was 2.5 times greater than the high socio-economic class. Drivers with the lower socio-economic class had a greater chance for both mild and severe injuries than their counterparts at the highest socio-economic class.	Age, socio-economic class, type of motorcycle, driving license, accident history
29	de Rome et al., 2011, Australia	Motorcycle protective clothes: Protection from damage or just the weather?	The motorcyclists and carrier aged 17-70 years	Data was collected through face-to-face interviews at home or two weeks after the accident in the hospital collected. Samples were selected from two hospitals and 13 repair shops of the motorcycle. Evaluation was conducted 2 and 6 months later by post.	The motorcyclists who had been worn protective clothes such as coats, trousers and gloves at the time of accident had less probability to be injured, but there was no relationship between wearing these clothes and the risk of fractures. The amount of fracture of these coverings due to the accident was as follows: coat: 29.7, gloves: 25.7 and trousers: 28.1%.	Accident, severity of injury, protective clothes, demographic characteristics

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30	Bambach et al., 2011, Australia and New Zealand	Typology of injury caused by fatal accidents by roadside barriers	The motorcyclists	Data of website of legal medicine was used. This data was included police reports of the accident such as sketch and the report of dissection and accident situation and the type of motorcycle.	The injuries to 31 motorcyclists were reported that the area of the chest and then the head injury had the highest injury in the fatal accidents. 1462 roadside deaths had been occurred.81% of the motorcyclists had been died at the accident scene. 97% of the motorcyclists had used helmets. The behaviors of speed and alcohol / drug consumption were identified as the common factors.	Demographic information, involved issue and the location of death, type of injury, severity of injury, the injured organ, speed, roadside accidental barriers, alcohol consumption
31	Carlos et al., 2011, USA	The risk factors related to driving and accident of the motorcyclist without a helmet	The motorcyclists	The motorcyclists who had an accident once during 13 years from 1994 to 2006 were selected and divided into two groups of with helmet and without helmet.Available data was entered into the computer and analyzed.	he motorcyclists with helmets suffer less injury. Drunken people and those without insurance and those in carrier are less likely to use helmets. The motorcyclists without helmet had the scale of severity of further injuries, less Glasgow Coma Scale (GCS), more blood pressure drop, worse results such as the severity of disability, needed more medical care and more hospitalization days.	The use of helmet, age, gender, ethnicity, insurance status, alcohol, being passenger or driver the motorcyclist, blood pressure drop, type of injury, score of the severity of the injury, score of GCS, the hospital of ICU, duration of hospitalization, hospital fees, function
32	Mayrose, 2008, USA	The impact of the mandatory law of motorcycle helmet and the injury patterns due to riding the motorcycle	Male and female motorcyclists	Mortality data was obtained from FARS reporting and (NCSA) analysis systems. The use of helmets among the motorcyclists in fatal accidents was investigated from 1995 to 2003 in all 50 states and districts of Columbia, Texas and Arkansas. The countries were divided into three groups of with a primary law, with a secondary law and without the law of helmet.	The use of helmets was 84% in the countries with the primary law of helmet, 36.2% with the secondary law of helmet, and17.6% in the countries without law, and 57.4% in general. Changing the primary law of helmet to the secondary law in 1997 was led to decrease the use of 78.2% in 1996 to 31.7 in 2000.	Age, gender, the severity of injury, the use of helmet
33	Ankarath et al., 2002, England	Injury patterns associated with the mortality due to the motorcycle accidents	The motorcyclists	Data was retrospectively collected for all motorcycle accidents. Data of victims from January 1993 to December 1999 was collected including demographic details, the use of helmet, clinical details, injury severity score (ISS), GCS, Emergency, therapeutic interventions, rehabilitation requirements, duration of hospitalization, and mortality.	The most severe fatal injuries were head, neck and face (11.8%), skull fracture (25%) and concussion (27%) and chest injury (17.4%).10% of the injured people had not been used the helmet. The most important variable affecting mortality was the head injury accidents. Therefore, wearing a helmet should be mandatory.	Head injury, fatal and serious injuries, demographic characteristics, helmet, severity of injury, therapeutic interventions, rehabilitation requirements, duration of hospitalization, and mortality

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34	Paulozzi et al., 2005, USA	The role of buying and selling the new motorcycles in the recent increase in the amount of deaths of the motorcyclists	Buyers of the new motorcycles	Data was retrospectively collected from the police reports of traffic accidents due to the model of motorcycles and related deaths in 30 days after the accident.	The motorcycles aged from 0 to 3 years were responsible for deaths of 33.4% in 1997 and 52.5% in 2003. The number of deaths had increased to 1495 people. When the sale of new motorcycles develops, exposure to their risks will be also increased due to inexperience.	Information about making the motorcycle, model, and model year for the motorcycle
35	Peek-As a et al., 1999, USA	The prevalence of the use of non-standard helmet and head injuries among the motorcyclists	The injured motorcyclists	The individuals were classified into 3 groups of the injured ones using standard helmet, non-standard helmet, and without helmet. The motorcyclists were observed from 29 locations. 5119 people were observed for two years.	1335 people were suffered from fatal head injuries. 375 people had non-standard helmets and 146 people were suspected to have non-standard helmets. The non-standard helmet provides little protection against the hit to the motorcyclist.	The use of standard and non-standard helmet, accident casualties, injuries
36	Kasantikul et al., 2005, Thailand	The role of alcohol in motorcycle accidents in Thailand	The motorcyclist	The research team rebuilt 12 weeks of training for the motorcyclists' accidents with the method of investigating the motorcycle accidents. Accidents were randomly sampled and were included all levels of injury severity by considering the cause of the accident, alcohol. Then, the motorcycle accidents in two alcoholic and non-alcoholic groups were prospectively compared by measuring the concentration of alcohol.	90% of accidents were due to alcohol and were frequently occurred on weekends and at night. 30% of the alcoholic riders were outpatient treated and 46% were admitted to the hospital. 11% of the consumers died in the accident that alcohol consumption was effective on 75% of those who had been died. 36.3% had been consumed alcohol before the accident.	Alcohol, weather, road type, motorcycle manufacturer, gender of the rider, time and day of the accident
37	Zulkipli et al., 2008, Malaysia	Spinal cord injury related to the motorcycle: accident feature	The injured motorcyclists	Data was obtained from the accidents reports of the royal police database MIROS during 2005-2007 and the motorcyclists' data was filtered. Then, the injured people were classified into 2 categories of spinal cord injury (experimental) and without spinal cord injury (control). Moreover, the Police Storytelling method was also used as an additional resource to describe the accident.	57.6 of the study subjects had severe injuries and 42.4 had been died of injury. There was a significant relationship between creating spinal cord injury and the situation and status of the accident and when the vehicle alone had an accident with the fixed objects.	Demographic characteristics, helmet, driving license, having a carrier, motorcycle capacity, time, day, type of road, type of vehicle, fixed roadside objects, the position of the motorcyclist
38	Magazz et al., 2006, Italy	Are the car drivers who have a motorcycle license less responsible for the accidents? A non-parametric approach	Drivers and passengers of all two-wheel vehicles	Data was obtained from the MAIDS database in 1999-2001.Samples were the injured people transferred to the emergency department. Each accident was rebuilt and analyzed by the statisticians, engineers, orthopedists and experienced motorcyclists. The same data except for the variables of describing accidents and injuries was collected for the control group.	The motorcycle drivers who have motorcycle license have less accidents as well as more control in driving than those without license which is due to the experience or the routine routes for them. The speed of motorcycles' riders is higher than other drivers (22.4 versus 13.8).	Mechanical, environmental and human variables, the location of the accidents happened, accident dynamics, mechanical characteristics of vehicles, the injury, personal, social and behavioral characteristics of drivers, driving experience with the vehicle, driving experience in general in any vehicle (year),age, vehicle speed before the accident, driving license

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39	Langley et al., 2000, New Zealand	The size of the motorcycle and the mean of the risk of fatality of motorcycle accidents	Motorcycle drivers	The motorcyclists on Auckland roads were selected in the three-year period from 1993 to 1996 (1518 people) who had been admitted to the hospital or to the emergency or had been died of accident. The control group was randomly selected from the same road, and both groups completed the questionnaire. Face to face interviews were conducted in the hospital or the relatives were asked by telephone if they were discharged.	The higher capacity of the cube of motorcycle, (250cc and above), the accidents will be also increased. There were 32 deaths of motorcyclists in the study. The use of headlights, having the carrier, and having the license also affected the accidents.	Time of accident, year of make, model and volume of the motorcycle, age, gender, low socio-economic status, speed, having the carrier, driving license, headlights, low experience
40	Gkritza, 2009, USA	Modeling the use of motorcycle helmets in the Iowa State: Evidence from 6 cases of the roadside observational studies	The drivers and carrier	An observational study of the drivers and carrier from 6 roadside locations was conducted. Then, The use of helmet by the motorcyclists and carrier was investigated and reported using a simultaneous equation model.	Road type, weather conditions and other factors affect the amount of use of motorcycle helmets and the government laws is one of the most effective methods of mandatory use of helmet. The use of helmets depends on whether conditions, caution in riding motorcycle is higher at the beginning of riding motorcycle.	Road type, weather conditions and location, the use of motorcycle helmets, government laws
41	Younesian et al., 2004, Tehran	Evaluation of the effect of the plan to intensify the punishment of the motorcyclists on the number of injured people caused by traffic accidents	Injured people caused by traffic accidents referred to the hospital	The study population was selected by census method within 1 month and data were collected by completing the questionnaire in 3 steps: 1 month before the intervention, the corresponding month of last year, and the month after the intervention. Required data were extracted from the records and were coded based on the international system of classification of diseases.	Daily mean of the injured people was increased in the first month of implementing the organizing plan and the corresponding month of the previous year, but the incidence of injuries caused by accidents as well as head and neck injuries was decreased. The results indicated that although the implementation of the organizing plan of the motorcyclists' traffic did not reduce the number of injuries, it had reduced the severe injuries and head and neck injuries by making changes in the pattern of incidence of these accidents.	Demographic characteristics, type of admission, time of referring, type of injury, location of injury, severity of brain injury, the condition of injured individual, the condition of the other party
42	Khosravi Shadmani et al., 2010, Tehran	Investigating the effect of some factors related to the person and vehicle on the status of fault in traffic	All accidents occurred in 2009	Data of all accidents occurred in 2009 were used by census method. After refinement and revision of data by the statistician and epidemiologist, the eligible samples were entered to the study and finally, 557,182 accidents were investigated by census method with the outcome of being guilty and being not guilty in accidents.	The most effective factor in the suburban axes was speed. Men had the greater chance (20.1) in urban axes and the less chance (0.5) of being guilty in the suburban axes.	Age, gender, speed, type of driving license, type of vehicle, status of fault
43	Rahmani Firouzjah et al., 2006, Babol	Sociological investigation of the causes of road accidents (Case study of Babol)	All road drivers	Data were collected through a questionnaire by 389 drivers.	Age, education, wisdom, fatalism, normative system, job satisfaction and the method to get a license, marital status, place of residence, type of vehicle and law-orientation affect the amount of accidents	Age, education, wisdom, fatalism, normative system, job satisfaction and the method to get a license, marital status, place of residence, type of vehicle and law-orientation

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44	Salmani et al., 2008, Isfahan	Investigating the factors affecting road accidents and providing strategies to reduce it	Field information of the villages of Isfahan	40 samples were selected from elites (literates, councils, and local reliable persons) of 7 villages were selected and the questionnaire was completed. Data of field survey during (1996-2006) was also used.	Human factors have played the most role with 54% that high speed, hurry up to arrive at the destination, failure to observe traffic laws, being sleepy drivers, illegal overtaking and the far distance and fatigue caused by it have played more role than other factors. Management factors 34% and natural factors 12% are other effective factors.	Human factors, management factors, natural factors, vehicle factors
45	Pak Gohar et al., 2007, Tehran	Investigating the causes and factors effective in reducing the accidents using regression models	Road accidents occurred in 2006	Road accidents occurred in 2006	The dead individuals were about 75 people a day and 64.5% of the accidents have been due to the lack of attention to the regulation. The contribution of human factors was 49%, vehicle 15%, and road 36%.	Human factors, road factors, vehicle factors
46	Farahmand et al., 2009, Tehran	Investigating the security status of the motorcyclists in the cities of Arsanjan, Eghlid, Kazeroon and Neyriz	the motorcyclist	1286 cases were systematically selected from the motorcyclists at crowded points of Mojri city and information was obtained through observation, interviews and completing the questionnaires.	92.1% did not have helmet, 35% had helmet, but only 4.6% were used it regularly. The reasons for the lack of use: inconvenience and heaviness 7.5%, embarrassment: 8.2%, forgetfulness: 6.8%, lack of hearing: 1.2%.Moreover, more than 70% of the motorcyclists believed that the use of helmets should be mandatory.	Demographic characteristics, the status of awareness and attitude of the motorcyclists of the benefits of using helmets, security behaviors including the registered plaques, carrying the huge burden with the motorcycle, carrying two or more people with the motorcycle, having driving license, incidence of accident, the reason for accident, incidence of injury and type of injury to the motorcyclist
47	Baghiani Moghadam et al., 2006, Yazd	Investigating the character and status type of accident in the injured motorcyclists	the injured motorcyclists	Data were obtained from direct referring to the injured motorcyclists (305 people) through the list of police stations randomly and using the questionnaire.	74% of the motorcyclists had an A-type character and 26% had B-type character.72.7% of the samples of type A did not observe the traffic laws and stated that the cause of accident has been the barrier.	Character type, demographic characteristics, performing insecure behaviors and inappropriate environmental and equipment conditions, time of accident
48	Alizadeh Aghdam et al., 2010, Tabriz	Drivers' cultural lifestyle, a tool to explain their traffic behavior	Urban drivers	The data collection tool was a questionnaire. 400 samples were selected by stratified random sampling from the drivers' gathering centers and completed the questionnaire.	The lowest mean of observing traffic behaviors was related to the illiterates and the highest was related to those who have academic education. The number of accidents is reduced with increasing the cultural capital of drivers which is the best way to reduce dangerous traffic violations.	The number of accidents is reduced with increasing the cultural capital of drivers which is the best way to reduce dangerous traffic violations.

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49	Khalaji et al., 2006, Qazvin	Risk factors of occurring the injuries caused by traffic accidents in road drivers of Qazvin, Lushan, 2005	drivers	Data was obtained from the interviews with the cases that were the drivers of all motor vehicles and had a traffic accident reported to the police station on the road during the period of conducting the study in the hospital and witnesses in the police station as well as using the reports of the police station.	The relationship between these cases and the occurrence of injury was showed in the analysis with multiple logistic model: the use of safety tools, thrown out of the vehicle, severe accident, and more accident of the motorcycle than the automobile, unfavorable weather conditions, the interaction of the severity of accident and weather conditions. The motorcyclists' riders had the risk of occurrence of injury 5.5 times higher than truck drivers and 7.03 times of automobile drivers.	The relationship between these cases and the occurrence of injury was showed in the analysis with multiple logistic model: the use of safety tools, thrown out of the vehicle, severe accident, and more accident of the motorcycle than the automobile, unfavorable weather conditions, the interaction of the severity of accident and weather conditions. The motorcyclists' riders had the risk of occurrence of injury 5.5 times higher than truck drivers and 7.03 times of automobile drivers.
50	Rasekh et al., 2008, Khuzestan	The study of mortality due to the incidence of unintentional injuries and accidents in Khuzestan province in 2001-2005	All dead individuals during 2001-2005 with the cause of unintentional accidents and incidents	Data of the causes of mortality due to the unintentional accidents according to the age and gender among all registered dead people were collected from information of legal medicine center and calculation of the amount of deaths.	The first three fatal accidents of all the study years were: 1- traffic accidents 2- burning with flames and fire smoke and 3- drowning in water. The mean of lost years of life has been 11.08 during 5 years that this percentage in men has been always higher than in women. The deaths from traffic accidents have had a growth of 11% in the 5 years of study.	Gender, city of birth, date of death, city of death, age at death, place of death, marital status, the source of diagnosis and the cause of death
51	Hatami et al., 2011, Karaj	Comparison of the character features of the drivers causing accident and normal drivers (a case study of Karaj city)	Comparison of the character features of the drivers causing accident and normal drivers (a case study of Karaj city)	Criterion group was the ordinary drivers and peer group was drivers causing accident. Karaj taxi was randomly selected from 20 taxi services and terminals with multi-stage cluster sampling method and the character features of the two groups of 35 people were measured by the NEOPI-R test.	The more age of people and driving experience, less causing-accident driving occur. Neuroticism and extraversion indicators in drivers causing accident and the indicators of being flexible, agreement and being conscientious in drivers of do not cause accident gained significantly higher scores.	Previous educational backgrounds of skill and character features of causing accident
52	Bahari et al., 2009, Roodehen	The relationship between the character features and attachment styles and risk-seeking youth	students	120 male and female students were selected and different questionnaires were used to measure the character features and attachment styles and risk-seeking.	Character features, attachment styles, gender and place of residence explain a total of 24% of the variance of risk-seeking students. The variables: gender, age and pleasantness have a significant predictive effect on the level of risk-seeking.	Age, gender, character features, attachment styles, place of residence, pleasantness
53	Haghshenas et al., 2008, Shiraz	The relationship between character features and driving behavior in Shiraz City (2005)	drivers	537 male and female drivers completed the Manchester driving behavior and NEO FFI questionnaires. Through sampling in the vehicle tag change agency and central specialized clinic Center.	There is a direct relationship between the amount of anger and the amount of types of errors and performing violent illegal acts and there is an inverse relationship between the amount of agreement and extraversion and the amount of types of errors and performing illegal acts	Age, gender, years of formal education, job status, years of driving experience, intentional and unintentional hazardous errors, violent and nonviolent illegal acts

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54	Hajlu et al., 2012, Ardabil	Predicting the driving behavior based on character features and sensation seeking	drivers	160 drivers of the drivers' gathering centers completed the Manchester driving behavior and NEO FFI questionnaires and Zuckerman sensation seeking scale with available sampling method.	There was a significant relationship between the age and number of accidents and driving behavior. Character features of neuroticism, agreement, sense of duty, and sensation seeking were predicted driving behavior. The mean of intentional violations in the motorcyclists was higher than other drivers.	Demographic characteristics, personality factors, the type of behavior and the amount of risk of that behavior for others, the individual' tendency for hazardous activities
55	Hefng et al., 2012, United Arab Emirates	Motorcycle-related injuries in the United Arab Emirates	The injured and hospitalized motorcyclists	The data were collected from hospitals during the 4 years (2003-2007). 95% of the injured motorcyclists were investigated.	The most injury (54%) was to the upper limb, then the lower limbs with 48%, the head with 41%, and the face with 30%.Mortality was 6%. The young motorcyclists and accidents related to the accident of motorcycle with automobile and being native the motorcyclist had the most prevalence in accidents.	Being native, risk-taking, type of stroke, time of incident, demographic characteristics

Table 4: Summary of qualitative and combined studies

Row	Author, year, country	Title	Study population	Type of study	Data collection method	The factors affecting the accident (Obtained themes)
56	Shams et al., 2010, Tehran	Tehran taxi drivers' views on hazardous driving behaviors: a qualitative study	Taxi drivers	qualitative	Selection of districts 4 and 6 of Tehran, 42 taxi drivers were divided into four groups and was were collected through a focused group discussion.	The best channels to communicate with taxi drivers and encourage them to modify hazardous driving behaviors is to use the behavioral interventions based on comments of audience. The use of encouraging messages to increase the drivers' attention to driving can be helpful (from the perspective of the drivers).
57	Zamani, Alavijeh et al., 2010, Tehran	Risk-taking behaviors in motorcyclists in the Middle East	Motorcyclist, carrier, police	qualitative	32 motorcyclists were selected through the available sampling method and data were collected using data collection methods of focused group (7 sessions), deep interview (29 people) and field observation.	Being young and single, poverty, poor physical health and stress affect the risk-taking behaviors. The lack of laws, access of adolescents without license to a motorcycle, the cost of effectiveness of motorcycle in transportation, insecure roads and the lack of special routes and reckless drivers of cars and trucks are the enabling factors of high-risk behaviors. Enjoy motorcycle riding and the lack of punishment for disobedience of the law intensify the high-risk behaviors.
58	Watson et al., 2007, Australia	Psychological and social factors affecting the intent and behavior of motorcyclists	Psychological and social factors affecting the intent and behavior of motorcyclists	combined	Data were obtained from the perceptions of 43 motorcyclists using a focused group method and a quantitative study (229 people) based on a self-report survey.	In the qualitative section, the themes: 1- skillful control of motorcycle 2- having a high level of focus 3- observing the road rules 4- heckler(includes any behavior that reduces consciousness and concentration) 5- ignoring the individual restrictions 6- high speeds were obtained. In the quantitative section: the perceived behavioral control structure was predicted the intention of be safe and attitude of intention of danger. The structure of subjective norms was a relatively poor predictor of behavior. Sensation seeking along with the violence of the motorcyclist were specified as a strong predictor of all 6 behaviors.
59	Zamani, Alavijeh et al., 2007, Tehran	Motives to use motorcycles in the motorcyclists with high-risk behaviors(A qualitative study)	Motorcyclist, carrier, police	qualitative	Target-based sampling was used with maximum diversity. Data were obtained from field observation and the registration of the behavior of 34 motorcyclists during driving, reports and information of the records existing in the police station and deep interview with 22 motorcyclists, carrier and police.	The four main themes were abstracted to describe the motivations of riding motorcycle including: the use of quick and easy vehicle in traffic, job necessity, meet the emotional needs, ease in committing crime and escaping from the law

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60	Zamani, Alavijeh et al., 2007, Tehran	Causes of high-risk behaviors in the motorcyclists: A qualitative study	Motorcyclist, carrier, police, existing records	qualitative	The integrated data were obtained from field observation and the registration of the behavior of 32 motorcyclists at different times and places, investigating the existing records in the police station and 13 deep interviews and 2 focused group discussions.	Causes of hazardous behaviors were classified into 5 main themes of the individual factors, socio-cultural factors, motorcycle status, abuse of security equipment and environmental factors.
61	Zamani, Alavijeh et al., 2007, Tehran	Motorcyclists' experience of hazardous behaviors: A qualitative study	Accident record of the motorcyclists	qualitative	Using the target-based sampling with maximum diversity and at different places through deep interviews (61 people) and field observation and the registration of the behavior of 34 motorcyclists	Motorcyclists' behaviors are two categories:1- unintentional behaviors (errors)due to the ability and experience and insufficient concentration while driving 2- intentional behaviors (violations)such as driving without paying attention to the health of the motorcycle and its parts, unauthorized use, the lack of use security equipment, dramatic movements, carrying a passenger or carrier at the front of the motorcycle, carrying huge and heavy burdens, failure to observing traffic regulations.
62	Arasteh et al., 2010, Tehran	The role of optimal interaction between the constabulary and education in promoting the culture of traffic order and security of the country	Experts of traffic and educational issues	combined	Quantitative and qualitative methods (content analysis) were used. The current status of the traffic doctrine was investigated in the textbooks. There was snowball sampling method and data collection methods were interviews, content analysis of documents and questionnaires.	Traffic contents do not have logical connection and technical errors in text and images are scattered. In addition to the limited size of the contents, combining theoretical traffic trainings with practical training and practice in the street has not been predicted. Due to being specialized the traffic issues, it is not clear whether the educators have the ability to teach it or not? All software, hardware, structural, theoretical training and practical training factors affect the interaction between the constabulary and education to promote the culture of traffic order and security. Achieving each of the three knowledge, emotional and behavioral dimensions of traffic culture was emphasized by the above factors.
63	Zamani, Alavijeh et al., 2011, Tehran	Frequency and predictors of the use of helmet among the Iranian motorcyclists: A quantitative and qualitative	drivers	combined	A hybrid approach was used including deep interviews (29 people) with motorcyclists and carrier and focused group and then a cross-sectional study was conducted with a dedicated observation of the use of helmets while riding motorcycle.	10% of the motorcyclists were used standard helmets and 23% non-standard helmets. The themes achieved were categorized into three categories: 1- properties of helmet 2- social and cultural factors 3-individual and physiological factors.

Table 5: Summary of the interventional studies

Row	Author, year, country	Title	Study population	Type of study	Data collection method	Description of the intervention	Amount of success of interventions
64	Woratanarat et al., 2013, Thailand	The program of healthy riding motorcycle and injuries related to the motorcycle in Thailand	motorcyclists	Interventional	Before and after training, information was collected through postal questionnaires. Moreover, 257 records of accidents caused by motorcycle were retrieved for analysis.	The intervention was included a multidisciplinary training course consisting of: 15 minutes of security recommendations before delivering the motorcycle for the new buyers, training 2 hours a day for students and in general, motorcyclists (including traffic rules, repair and maintaining the motorcycle, techniques for riding motorcycle, secure riding and understand the risk using the simulator), 100 hours of playing movie for practical demonstration of skills including setup, move and control of motorcycles, gear shift, right and quick brake, discussion about the road twist, race on the twisted road with barrier, narrow roads, intersections, bridges, and transportation of the passenger and keeping balance, a 15-hour license course for students and drivers and a 30-hour course for instructors and salespersons, and after completing these steps, the license was issued automatically. The control group was matched one by one in terms of training groups of district and the date of getting license.	Age and gender (male) were significantly related to the accidents caused by motorcycle and every one year of changing the age was led to a 2% reduction in the risk of the motorcyclist accident. The trained individuals had been 30% less injured and in general, the training course had been reduced the risk by 29%. The prevalence of motorcycle-related injuries was 21.8% before training and 10.3% after training. There has been improvement in understanding the secure behavior in riding motorcycle in most people in the training group (93.5%) and they were felt more confidence in riding motorcycle (96.9%).
65	Souri et al., 2010, Tehran	The role of police assistants in the amount of traffic violations and accidents in the country	students	Interventional	The study samples were 2800 students aged 8 to 15 years old in six education districts of Tehran. The samples were selected by multi-stage cluster sampling. The intervention was the police assistant plan. Information was collected from police reports.	Police assistants were included four groups of first assistant (pre-school students), first grade elementary (second assistant), second and third grade elementary students (third assistant), fourth and fifth grade elementary students (police assistant) and first grade guidance students.47.7% of the assistants were boys and the rest were girls. Do not fasten seatbelts (39.1%), talking with cell phone (31.8), and non-authorized speed (29.8) were three major violations which were more reminded by the police assistants. Violations and accidents registered were collected from traffic police information systems in the last six months.	The amount of violation was reduced to 17.9% in the year after the intervention. The most cases of violation reduction was related to eating and drinking while driving (92.7%). Reduction was observed in all cases of trained except talking with cell phone while driving which had been increased.
66	Swadd-iwudhipong et al., 1998, Thailand	The effect of training motorcyclists on changing high-risk behaviors and injuries caused by motorcycle accident	Village people in two control and experimental groups	Interventional	A community-based program for training motorcyclists was randomly implemented in three villages. Then, the program was followed up for 2 years until 1997.	Community-based training programs (training the cases related to the motorcycle injuries and epidemiology of accidents, the benefits of helmet, the risks of insecure riding motorcycle, traffic signs and rules) were presented and interviews with the motorcyclists in 16 villages about the effects of training programs were done by the health education specialist and physician, hospital and police reports were collected and training was conducted through mass media.	The amount of injuries was significantly decreased in the intervention areas compared to the control (6.4%). Although the amount of mortality had been decreased, was not significant (0.4).The amount of use of helmet and getting license was increased 25.5% and 23.2%, respectively in the intervention group.

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67	Mehri et al., 2011, Yazd	The effect of training based on the theory of planned behavior on the amount of use of helmets in the motorcyclist staff	Motorcyclist staff of the offices in Yazd	Interventional	The questionnaire designed based on the theory of planned behavior by interview with 120 people was completed, educational content was compiled and was presented to the experimental group (60 people).	The training program was developed and presented to the experimental group according to the results of the questionnaire. Training program was presented for 10 days using lectures and question and answer (a 45-minute session), face to face training (at least 5 minutes for poster), and training aid materials including posters and pamphlets. The control group received no training program. Data were collected again one month after implementing training program to minimize the effects of environmental conditions.	The most important barrier to use helmet (86.6) is the feeling of heat when use. Abstract norms and attitudes (59%) were predicted the intention of use of helmets and the direct effect of control perceived behaviors was more than other variable. Implementing the training program was effective on all variables of the pattern and was effective on the intention of use of helmets more than all.
68	Baldi et al., 2005, Colombia	Identifying the best practice for training and issuing license for the motorcyclists	the motorcyclists	Interventional	First, published documents, internet websites, government programs and comments of the government managers of motorcycle security were used to confirm the registered data and several variable were investigated in this data. Then the intended model was designed and validate.	According to the studies conducted, the best model was designed for issuing license which was the best model to help the health of the motorcyclists, policymakers and researchers from the perspective of the authors in order to identify the factors contribute to high-quality training for the motorcyclists and issue the license. The criterion for evaluating the validity of the proposed model was to reduce the mortality of motorcyclists. To evaluate the validity of the model, four variables were used: the criterion for the best practice, trips of the vehicle to miles, the number of registered motorcycles and the number of registered licenses for the motorcycle operator.	There was a negative relationship between proposing the model and the mortality of motorcyclists. The lowest mortality rate of the motorcyclists was observed by proposing this model. Due to the increase in motorcycle accidents, it is very important to investigate the defects of program using the experiences of other countries and to use efficient and cost effective strategies to apply the best practice in training motorcyclist and issuing the license.

From 41 studies in the world, the frequency of Australia was identified with 10 cases of study, America with 7 cases, Thailand and England each with 3 cases, Canada and New Zealand each with 2 cases, and other each with 1 case, respectively. The number of studies conducted in Iran was 27 cases that about half of them, had been conducted in Tehran. The information about the type of studies is shown in Table 6.

In terms of the factors studied, the studies were divided into four categories as table 7 shows.

Table 6: Classification of studies based on the type of factors studied

Row	Characteristics of studies	Iran studies	World studies	Total studies
1	Investigation of human factors associated with traffic accidents of motorcyclists	27	41	68
2	Investigation of environmental factors associated with traffic accidents of motorcyclists	6	7	13
3	Investigation of environmental factors associated with traffic accidents of motorcyclists	7	8	15
4	Investigation of environmental factors associated with traffic accidents of motorcyclists	15	22	37

Each of the above mentioned factors includes sub-components that show the type of effective factor better and in more detail. These sub-components are classified in Table 11 to better understand their effect on occurrence of the accident:

Conclusion

Unfortunately, the motorcyclists are a group that has been relatively neglected in research as less than a third of all identified studies have focused on accidents in motorcyclists. Among these, few studies have contributed to better understanding of the strategies to reduce their risk or have properly evaluated an Intervention to reduce their risk.

However, in general, these reviews showed that severity of injuries caused by motorcycle was higher than other vehicles, men are at more risk of traffic accidents than women, most deaths were observed in the age group of 25-5 years old, and lower economic status. In addition, half of the road injuries had happened between 12 AM-18 PM and the Review studies showed that the most effective preventive measure in accident-related behaviors had been structural and environmental reform, while training can have a very positive effect on the reduction of accidents done by face-to-face communication in small groups.

Table 7: Classification of the studied factors in the studies

Factors	Sub-components
Human	1-The amount of crime and its types in relation to the motorcyclists 2-riding motorcycle training 3- the lack of concentration 4- sensation seeking 5- risk-taking 6- to race 7- bragging 8- reported culprit 9- motivation of the use of motorcycle 10- understanding the risk of riding motorcycle 11- history of causing accidents 12- motorcycle ownership 13- ownership of motorcycle license 14- type of injury / death 15- characteristics of the pedestrian involved in the accident 16- number, gender and age of the motorcyclists 17- alcohol or drugs consumption 18- secure behaviors of riding motorcycle 19- talking on cell phone 20- unauthorized overtaking 21- carrying heavy burden 22- riding motorcycle on the sidewalk 23- insufficient experience 24- attitude of the motorcyclist 25- time of getting license 26- economic status of the motorcyclist 27- health status of the motorcyclist 28- character type of the motorcyclist 29-enjoying riding motorcycle 30- reaction time of the motorcyclist 31- having hurry while riding motorcycle 32-fatigue while riding motorcycle 33-knowledge and attitude of the motorcyclist 34- accident-related behaviors
Legal	1-motorcyclists-related rules 2-how to give the license 3- violation and avoidance of the police 4- the amount of arresting motorcycle 5- escaping from the law
Vehicle	1-technical problem 2-the amount of types of motorcycle 3- characteristics of the motorcycle causing accident 4- rate of speed of the vehicle 5-having secure equipment
Environmenal	1-the sudden accident with the obstacle (the existence of bump) 2-bad weather 3-slippery road 4- the general condition of roads and streets 5-the darkness of air 6- other drivers 7- not seen 8- road crowdedness 9-a separate route for riding motorcycle

As reported by the World Health Organization (2, 3), the factors affecting the incidence of accidents include human, environmental, vehicle and legal aspects. Review of 41 descriptive-analytic studies (15-30, 57-81) indicated that several factors had significant ad meaningful relationship with higher risk of accidents among motorcyclists. These factors includes individual factors such as age group, speed and weak road infrastructure, low driving experience, inadequate training, risky driving behavior especially unauthorized overtaking, alcohol consumption, low education, low socio-economic status, marital status, faulty motorcycles, lack of driving license, risk taking personalities and character type, not obeying the traffic rules, being sleepy or tired, and environmental factors such as weekend holidays and especially nights, natural factors such as light, inappropriate weather conditions, driving culture. It can be said that almost all explored papers in this review have studied to different degrees, human factors. Human factors have been the most effective factor in the incidence of accidents (17, 18). After human factors, legal factors and then vehicle and finally the environmental factors were studied in reviewed papers with less frequency.

Investigation of 8 qualitative and combined studies (31-37) showed that being young and single, poverty, poor physical health, stress, the lack of laws, access of adolescents without license to the motorcycle, insecure roads and the lack of special routes and reckless drivers of cars and trucks, enjoying motorcycle riding and the lack of punishment for disobedience of the law affected the risk-taking behaviors.

Also, the causes of hazardous behaviors were classified into 5 main themes of the individual factors such as not using security equipment, socio-cultural factors, motorcycle status, and environmental factors. According to the drivers' views, the use of behavioral interventions based on audience comments is the best way to modify hazardous driving behaviors. It can be said that these studies have considered high-risk behaviors and identifying these behaviors can be very helpful in this regard due to the goal of health education which is changing behavior, because extensive analysis of behavior is conducted to provide a general image of the current patterns and trends of driver behavior, and the interventions are also determined and designed by considering four key areas of behavior including: formation and creation of behavior, maintain and strengthen and control behavior based on ethical principles (43).

Reviewing 5 interventional studies (38-42) showed different success rates. For instance, the success amount of these studies in reducing the risk of accident after training was obtained at 30%, reducing violations 17.9%, reducing the amount of injuries 6.4%, reducing the amount of death 0.4%, increasing the amount of use of helmet 25.5%, and increasing getting license 23.2%.. It was reported that some modifiable risk factors of motorcycle accidents and their severity can be reduced. For example, it was reported that training can improve understanding of secure driving behavior, feeling of confidence, motivation to get driving license, and behaviors such as use of security equipment, obeying traffic rules, and finally reduce injuries and mortality caused by motorcycle accidents.

This review provides a long list of different type of influencing factors on motorcycle accidents and their severity. But it doesn't indicate which factor is more important. Future research and programs should take into account the identified influencing factors on motorcycle accidents and their severity as mentioned above. Considering that in different countries and even different cities in one country, the role of each factor might differ, it is suggested that before any interventions, the most important influencing factors in that social context is explored and then interventions are targeted addressing those factors. This approach will increase the chance and rate of success in reducing the accidents and their severity. This review also reveals that shortages and gaps in road traffic accidents among motorcyclists. There is a great need for more comprehensive interventional studies

which include different types of influencing factors and not just individual factors helping to identify best practices for reducing motorcyclist accidents.

However, generalizing findings and suggestions of this review should be considered in light of its limitations. This study was not completely systematic, it was not possible to compile the results as they had used different tools, focused on different factors, and implemented different strategies.

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